

Express Mail Label No. EL700401189US

PATENT
Docket 9437.17

UNITED STATES PATENT APPLICATION

of

RICK V. MURAKAMI,

DAVID MILLER,

and

MATTHEW W. PETTIT

for

**DEVICE USING HISTOLOGICAL
AND PHYSIOLOGICAL BIOMETRIC MARKER FOR
AUTHENTICATION AND ACTIVATION**

KIRTON & McCONKIE
1800 Eagle Gate Tower
60 East South Temple
Salt Lake City, UT 84111-1004
Telephone: (801) 328-3600
Facsimile: (801) 321-4893

BACKGROUND OF THE INVENTION

Related Applications: This application claims priority to provisional patent application 60/175,460, filed January 10, 2000.

5

Field of the Invention: The present invention relates generally to a biometrically activated device. More specifically, the invention relates to a biometrically activated device capable of authenticating or verifying a user's identity based on a unique internal biometric marker, or combination of unique internal biometric markers, of a user, thereby allowing or denying access to and/or control over an electronic component.

10

State of the Art: Security devices have been around for ages. From draw-bridges to locks on doors and furniture, people have attempted to secure their well-being and personal belongings from harms way. As technological advances were made, new means of security were created. Door locks require codes to disengage the lock, car doors are equipped with number pads, vehicle ignition keys include microchips encoded to communicate with the vehicle so as to prevent theft. Financial transactions have also become more secure. Currency is more sophisticated in order to thwart copying, credit cards require authentication signatures, bank account access requires account numbers, and personal identification numbers are issued for everything from calling cards to internet access to stock market trading accounts.

15

20

As technology continues to advance at a rapid rate, the search for more sophisticated, unbreakable, security measures continues. The key to an effective security system is the identification of the individual or entity attempting to access that which is protected by the security system, be it a home, financial information, or communications. Mechanical keys can be copied, personal identification numbers stolen, and credit cards misused without much trouble. The level of theft is evident from the billions of dollars in fraudulent financial transactions taking place each year, stolen vehicles, and home break-ins. Of particular

25

concern is the relatively new crime wherein a persons 'identity' is stolen. In this day and age, a person's identity is closely tied to a bank account number, a phone number, an identification number, a social security number, or other such information which is easily stolen and then used to access the owner's information or property. When such a crime occurs, the victim suffers financial decimation, credit destruction, and countless hours of agony in attempting to 'rebuild' their 'identity'.

One form of fraud involves electronic transaction fraud, such as fraudulent credit and debit card transactions. Typically, a magnetic strip on one surface of such cards carries an electronic form of a series of numbers, which identifies the account to be credited or debited. To execute a financial transaction using such a card, all that is needed is the series of numbers and authentication that the card is being used by the authorized user. Such authorization typically consists of photo identification or verification of a signature if the card is being used in a person to person transaction. Transactions conducted through other media, such as the telephone or over the internet, are often authenticated using some other form of identification, such as the billing address or phone number of the authorized user of the card. Because this information is often readily available to the public, such authentication processes are not very secure.

In the electronic transaction market, efficient identification of people is not only very critical, but very difficult, due to the rapid nature of monetary exchanges. In cases of pure electronic transactions, there is no physical document that acts as a transaction mechanism. In addition to this, most electronic transactions are performed from a location that is remote relative to the funds involved. The identification of the holder of the transaction device, such as a credit card, is the responsibility of the merchant or third party willing to accept an electronic transaction. Accurate identification and authentication of the validity of the transaction device is not always possible and, even when obtained, is not always accurate.

The advent of the internet has added an entirely new dimension to the problems associated with electronic transaction fraud. The internet provides a medium wherein the user of a transaction device and a third party willing to accept an electronic transfer of funds

never have any actual contact. This creates further authentication problems for the third party because the transfer device is not physically present, the identification of the user is not visually apparent, and a telephone number cannot be authenticated. As a result of the increased use of e-commerce, and ensuing authentication difficulties therewith, the incidence of electronic transaction fraud has been on the increase. In the immediate future, the opportunity and incidence of fraud will increase correspondingly unless sufficient security measures capable of positively identifying an individual are implemented.

The market has responded to the difficulties of authenticating electronic transfer devices, and positively identifying individuals, by searching for a viable biometric solution to the problems. Biometric technology generally involves the electronic identification of an individual using physiological traits which are unique to that same individual. Fingerprints are an excellent example of a biometric marker used for years to provide the unique identification of individuals. Because a fingerprint is unique to an individual, the identity of that individual may be determined through an analysis of the fingerprint. Thus, the identity of the individual, determined from a fingerprint, may act as a 'key' to unlock data or allow access through a door.

In particular, fingerprints have been used to secure some transactions and have been proposed for use in other areas. Many banks require that a finger print or thumb print of a person cashing a check be placed on the check. This allows the bank to later verify or identify anyone passing fraudulent checks. Along a similar line, it has been proposed that Automated Teller Machines (ATM) be equipped with fingerprint pads to provide further security to ATM transactions. An ATM having a fingerprint pad would require the user to validate their ATM card by way of their fingerprint. This could be accomplished by inserting the ATM card into the machine, entering a Personal Identification Number (PIN), and then requiring the user to place their thumb or finger on the pad so that the ATM machine can analyze the fingerprint and confirm the identity of the individual using the card. Such a system would necessarily rely on a database built into the ATM or connected to the ATM, to provide a list of users and corresponding fingerprint information. The fingerprint of the

user could be compared to the data in the database to confirm that the ATM card being used did in fact belong to the person associated with the fingerprint placed on the fingerprint pad of the ATM.

Other known biometric markers include palm prints, iris scans, proportional
5 comparison of physical traits, and voice recognition. For the most part, these biometric markers, like the fingerprint, are external physiological traits or characteristics. Information unique to an individual is gathered through various scanning processes which scan a external biometric marker of an individual. A number of United States Patents discuss biometric devices which may be used to help identify a person. Examples of external biometric devices
10 include those described in United States Patents: 4,537,484; 4,544,267; 4,699,149; 4,728,186; 4,784,484; 5,073,950; 5,077,803; 5,088,817; 5,103,486; 5,230,025; and 5,335,288 Internal biometric data has also been used to verify that a subject is alive. Such verifications have been accomplished by passively verifying physiological process, such as registering electrical impulses (EKG), or actively verifying physiological norms by
15 introducing and capturing a modified signal, such as introducing light energy to determine blood gas content (pulse oximeter). Examples of such biometric readings are describe in United States Patents: 5,719,950; and 5,737,439. The disclosures of each of the patents listed above are hereby incorporated by reference.

One of the downfalls of using the devices which are currently available in the market
20 for analyzing external biometric markers is the cost of installing the necessary scanning devices to provide the required security. For each different trait to be tested, whether it is a fingerprint, retinal scan, voice print, or the like, a different piece of expensive scanning equipment is necessary. Installation of such equipment into machines such as ATMs is economically impractical because each ATM would require the installation of the expensive
25 scanning device.

Another downfall of the biometric scanning devices currently available is their size. The necessary scanning equipment is bulky, making it impractical to attach the scanning

equipment to portable devices such as cell phones, credit cards, personal data assistants, portable computers, and the like.

Further, incompatibility across multiple systems renders the deployment of standard biometric identification on a wide scale very challenging, if not impossible. In addition, large databases storing the vast amount of data necessary to authenticate biometrically activated transactions or authentications result in further costs which have heretofore made biometric identification a poor candidate as a security device for low level or mass produced systems.

The downfalls of the current biometrically activated security systems can be overcome through the use of portable biometrically activated devices which only store the biometric profile of a single individual or a small group of individuals. The use of unique internal biometric markers, rather than external biometric markers, provides advantages which overcome the downfalls of the present biometric scanning devices used for security and the identification of individuals.

BRIEF SUMMARY OF THE INVENTION

The present invention provides an apparatus and process which utilizes unique internal human biometric markers to verify the identity of the user of the biometrically activated device or provide access or control over an electronic component. More specifically, the biometrically activated device of the present invention allows non-invasive access to a unique internal biometric marker, or some combination of unique internal biometric markers, and compares the scanned biometric marker to a biometric marker or profile stored within the biometrically activated device, thereby attempting to verify the identity of an individual using the biometrically activated device. A biometric marker, for the purposes of this invention, is a human internal physiological characteristic, or biologically active feature, which, preferably, is unique to each individual member of the human race. The biometric markers of the present invention are not merely measurements of superficial anatomical structure, but instead utilize or alternatively include measurements

of physiological traits of the various systems of the human body and/or are histological traits associated with tissues of the human body. In addition, a unique biometric marker is one which does not significantly vary over time such that the biometric marker is always unique to the individual. The device scans a selected body part or biological feature of the user,
5 taking an internal biometric measurement or recording internal biometric data from the same.

A biometric profile of the subject attempting to activate the biometrically activated device may be electronically constructed from the data or measurement obtained. The profile, measurement, or data is then analyzed and compared to a stored biometric profile,
10 or profiles, to determine whether or not the user is authorized to use the device or access the information that the biometrically activated device is protecting. As with a conventional door key, the authorization or verification of a valid user triggers the biometrically activated device to unlock certain information or activate or provide access to that which the device is protecting.

In its simplest form, the biometrically activated device comprises a biometric sensor and a memory module. The biometric sensor obtains the requisite internal biometric measurements or data from a user and compares the measurements or data to a biometric profile stored within the memory module. If the biometric profile stored in the memory module matches the measurements or data obtained from the user of the biometrically
15 activated device, the biometrically activated device provides access to the data stored within a memory module, triggers the disengagement of a locking mechanism, or performs a function on a mechanical device.
20

The biometrically activated device transmits or emits energy towards a human user. A portion of the emitted energy is reflected back to the biometrically activated device where it is received. The received signal is then transformed into an electric signal which represents
25 a unique biometric profile of the user. The profile may then be compared to a biometric profile stored in the memory module of the biometrically activated device. If the user's profile matches a profile stored within the memory module, the biometrically activated

device is activated or is permitted to function in the manner in which it is programmed to function.

The biometrically activated device can provide a means to control access, secure information, initiate electrical components, or provide a general security system. The internal biometric marker or combination of markers scanned is unique to each individual and, thus, difficult or impossible to otherwise reproduce. Likewise, the biometric profile stored within a biometrically activated device is unique to the device. Without knowledge of the specific internal biometric marker or markers scanned by the biometrically activated device, a biometric profile cannot be reverse engineered or reconstructed so as to activate the biometrically activated device. In other words, the biometrically activated device may scan a user for numerous unique biometric markers, however, without knowing which marker is compared within the memory module, reverse engineering is virtually impossible. In this fashion, the biometrically activated device provides superior security features over present day security systems.

The biometrically activated device of the present invention focuses on internal biometric markers unique to a specific individual, instead of external biometric markers, such as fingerprints, or non-unique biometric markers, such as blood pulse readings, and overcomes the problems associated with traditional security systems to provide a more viable alternative to the external biometric sensors currently available.

BRIEF DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims particularly pointing out and distinctly claiming that which is regarded as the present invention, the advantages of this invention can be more readily ascertained from the following description of the invention when read in conjunction with the accompanying drawings in which:

FIG. 1 is a schematic of a preferred embodiment of a biometrically activated device;

FIG. 2 is a plan view of one embodiment of the biometric device of the present invention;

FIG. 3 is a cut-away plan view of the biometric device of FIG. 2;
FIG. 4 is a plan view of the biometric device of FIG. 2 in an activated state; and
FIG. 5 is a plan view of the back side of the biometric device of FIG. 2.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

Generally, the biometrically activated device of the present invention comprises a sensor for sensing or determining certain internal biometric markers of a user in communication with a memory module for storing biometric data or biometric profiles of a user or users corresponding to the internal biometric markers obtained by the sensor. When a user attempts to activate the biometrically activated device, the biometric sensor creates a biometric profile of the user and compares that profile with the stored biometric profile of an authorized user. If the user's profile does not match the profile of an authorized user, the data or information stored within the biometrically activated device is unretrievable. However, if the user's profile matches that of an authorized user, the biometrically activated device becomes activated for a set duration of time, thereby providing access to the data or information stored within the biometrically activated device or allowing the user to operate an apparatus which the biometrically activated device protects.

The biometric sensor is configured to determine specific unique internal biometric markers of a user. In a preferred embodiment of the invention, the sensor includes an emitter and a receiver. The emitter emits light or another form of energy which is partially absorbed and partially reflected by a portion of flesh of a user. Such light or energy may include, but is not limited to, ultrasonic energy, infra red light, near infra red light, ultra violet light, specific wavelength-visible or nonvisible light, white light, or electrical signals. The receiver collects those portions of light or energy that are reflected from the user. Based upon the light or energy reflected, data relating to internal biometric markers may be determined and a biometric profile of the user may be constructed. Some of the internal biometric markers which may be measured or determined from the biometric sensor include, but are not limited to, bone density, electromagnetic waves, cardiac rhythms, diacrotic notch readings, blood

oxygen levels, capillary density, glucose levels, hematocrit levels, or sub-dermal layer analysis. Other biometric markers, such as bio-electric signals, resistance, impedance, capacitance, or other detectable electrical signals emanating from the body may also be detected by the sensor and used or combined with the feedback to the receiver to create a biometric profile of the user.

The biometric sensor may also include an activation device for activating the biometric sensor so that the biometric sensor is not always activated. Examples of the biometric sensor portion of the biometrically activated device of the present invention are more fully explained in the examples described below.

The memory module of the biometrically activated device is capable of receiving and storing data. The memory module is also capable of performing functions on the stored or received data to effectuate the creation of a biometric profile for a user. A biometric profile is based upon an internal biometric marker or markers of the user. Energy signals obtained from the biometric sensor may be converted into electrical signals which in turn may be converted to a biometric profile based upon a mathematical algorithm or transformation. The memory module may also store the commands or programming which will allow access to the apparatus being protected, or stored data such as phone numbers, account codes, or other information which a user wishes to keep private. Examples of the memory module of the present invention are further explained below.

Because the biometrically activated device is based upon a user's profile, the biometrically activated device is at least capable of accepting an initial biometric profile corresponding to the desired authorized user. The profile may be determined from the first use of the biometrically activated device or, alternatively, programmed before the first use in accordance with predefined biometric profiles.

FIG. 1 illustrates a schematic of the preferred embodiment of the biometrically activated device of the present invention. The device 50 includes a biometric sensor 60 and a memory module 70. The biometrically activated device is activated by the contact of a user 80 with the biometric sensor 60 of the device 50. Preferably, the user 80 will activate the

device 50 by placing a finger on the biometric sensor 60 for a period of time sufficient for the biometric sensor 60 to perform a scan of at least one unique internal biometric marker of the user 80. It is also understood that the device 50 may be remotely activated or may be maintained in an activated state.

5 Activation of the device 50 triggers the emission of energy 65 from an emission device 61. The energy 65 is directed towards a user 80 where it is both absorbed and reflected. The portion of energy 65 reflected back at the device 50 is measured by a receiving device 62. The receiving device 62 interprets the amount of energy 65 received and converts the energy into an electrical signal 66 which is communicated to the memory
10 module 70 of the device 50. In alternate embodiments, the energy received by the receiving device 62 is converted to an electrical signal 66 by a translator (not shown).

 The memory module 70 receives the electrical signal 66 and begins an authentication process of comparing an internal biometric marker, or markers, of the user 80 with the biometric marker, or markers, of the authorized users stored in the memory module 70. The
15 characteristics of the electrical signal 66 represent the internal biometric marker, or markers, which the biometric sensor 60 obtains from the user 80. The memory module 70 compares the electrical signal 66 to a known biometric profile 76 stored within the memory module 70. If the electrical signal 66 is identical to the known biometric profile 76, the biometrically
20 activated device has authenticated the user 80 and allows access to the data 72 stored within the memory module 70. If the electrical signal 66, is not authenticated, the biometric device 50 denies access to the data 72 stored within the memory module 70. Preferably, when access to the data 72 is denied, the biometric device 50 automatically turns off.

 Although the electrical signal 66 may be directly compared to the known biometric profile 76, the electrical signal 66 may also be transformed within the memory module 70
25 prior to comparison with the known biometric profile 76. The electrical signal 66 may be transformed into a mathematical representation or value based on algorithms programed into the memory module 70. The algorithms typically represent the necessary transforms needed to interpret the internal biometric marker represented by the electrical signal 66. The

mathematical representation or value, which represents the biometric profile of the user 80, is compared to a known biometric profile 76 stored within the memory module 70. If the mathematical representation or value is authenticated, access to the data 72 stored in the memory module is allowed.

5 Once accessed, the data 72 stored within the biometric device 50 may be displayed in some manner or used to perform an act on another device. For example, the data 72 may be displayed on an output device. Likewise, the data 72 may trigger the execution of a program within the memory module 70 such that the memory module 70 causes the actuation of a device, such as a door lock, in communication with the memory module. Further
10 examples are described herein.

FIG. 2 illustrates another preferred embodiment of a biometrically activated device: a credit card. A biometrically activated device is an integral portion of a biometric device 100, which in this case has the same shape, size and dimensions as a typical credit card. It is understood, however, that the shape, size, and dimensions of the credit card are not
15 limiting to the invention.

As illustrated, the biometric device 100 includes a biometric sensor having a light emitter 112 and a light acceptor 114. The biometric sensor 110 may additionally include an activation device 116 as shown in FIG. 2. Activation of the biometric sensor 110 triggers the light emitter 112 to emit a light 113. An example of a suitable light emitter 112 is a light
20 emitting diode (LED). Various types of LED's or alternative light sources may be substituted as the light emitter 112 depending upon the desired wavelength and characteristics of light 113 emanating therefrom. The light acceptor 114 can be any device capable of absorbing reflected light 113.

In normal use, an individual wishing to use the biometric device 100 places a body
25 part, such as a thumb or finger, over the biometric sensor 110 such that light 113 emitted from light emitter 112 is directed toward the body part and is reflected back towards the light acceptor 114. Typically, the biometric sensor 110 will include an activation switch 116 which activates the biometric sensor 110 when a body part is placed over the biometric

sensor 110, and causes light 113 to be emitted from the light emitter 112 for a fixed duration of time. Light 113 is partially absorbed and partially reflected by the body part covering the biometric sensor 110. Reflected light 113 is monitored by the light acceptor 114.

5 A preferred embodiment of the invention utilizes an infra red LED, which emits sufficient infra red light to penetrate the epidermal layer of skin of a user. A portion of the infra red light is reflected back to the light acceptor 114 while the remainder of the light is absorbed or lost. Based upon the amount of light reflected back to the light acceptor 114 over a period of time, a biometric profile may be established. The portion of the light signal received by the light acceptor 114 is compared to biometric data or a biometric profile stored
10 within the biometric device 100. If the light signal is identical to the biometric profile stored within the biometric device 100, the biometric device is activated. Where the light signal does not correspond to the stored biometric data or profile, the biometric device is not activated and the biometric sensor 110 is temporarily turned off.

Activation of the biometric device 100 requires proper identification of the user of
15 the biometric device 100. FIG. 3 depicts a cut-away plan view of the biometric device 100 exposing a memory module 120 in communication with the light acceptor 114 of the biometric sensor 110. The biometric profile of the authorized user is stored within the memory module 120. Other data, such as account codes, names, addresses, pass codes, or graphics, may also be stored within the memory module 120. Once a biometric profile of the
20 user is constructed by the biometric sensor 110, the user's biometric profile is compared to the biometric profile stored within memory module 120. If the user's biometric profile matches that of the biometric profile of the authorized user stored in the memory module 120, the memory module allows access to at least a portion of the additional data or information stored within the memory module 120.

25 The biometric sensor 110 may also include a translator (not shown) which interprets the level of light or energy received by the light acceptor 114 and constructs a biometric profile based upon the data received. The translator may also be an integral portion of the light acceptor 114 wherein the amount of accepted light is transformed into an electric signal.

The biometric profile is then compared to the biometric data or profile stored within the memory module 120.

Upon activation of the biometric device 100 of FIGS. 2 and 3, the memory module 120 releases the information, such as account information, required to perform an electronic transaction. The information stored in the memory module 120 may be released in a number of ways. As illustrated in FIG. 2, only a portion of the account numbers 150 are embossed on the biometric device 100. In the instant example, a blank liquid crystal display (LCD) 155 is positioned next to the account numbers 150. Upon activation of the biometric device 100, the memory module 120 activates the LCD 155 and communicates the information necessary to display the remaining account numbers 151 on the LCD 155, as illustrated in FIG. 4. Likewise, upon activation of the biometric device 100, the memory module 120 may repeatedly send account information to a magnetic transmitter 160 on the biometric device, as depicted in FIG. 5. The magnetic transmitter 160 shown in FIG. 5 may reside in the same location occupied by the magnetic strip of a credit card, such that the biometric device 100 may be used in the same manner as a credit card upon activation.

Other methods or devices for communicating the data or information stored within the memory module 120 may also be used. For example, the LCD 155 could be replaced with LED's or alternative display devices. Likewise, the magnetic transmitter 160 may be replaced with a digital device providing digital signals for a transaction or a light emitter which would release the data or information stored in the memory module 120 by the emission of visible or non-visible light.

It is intended that the biometric device be self-calibrating. For example, the original biometric data or profiles stored in the memory module 120 may be calibrated through repetitive use. As the biometrically activated device is used, the biometric profiles obtained are averaged such that a specific number of the most recent successful biometric readings, offset by the original biometric profile, are used to create a more complete biometric profile of the authorized user.

As part of the built-in security feature, the biometric device 100 can automatically deactivate. For example, the memory module 120 may be programmed such that, once the user is authenticated and the biometric device is activated, the memory module 120 will display the account numbers 150 on an LCD 155 and/or repeatedly send account information to a magnetic transmitter 160 for a fixed duration of time. Thus, access to the information stored within the memory module 120 may be limited to a specific period of time needed to carry out an electronic transaction. This feature advantageously prevents the unnecessary display of account numbers 150 and electronic copying of information permanently stored in magnetic strips of current credit cards. In addition, because the biometric device 100 may only be activated by the authorized user, others are prevented from using the biometric device 100 to perform an invalid transaction.

The biometric device 100 may further include a power source 170 to supply the necessary energy for the operation of the biometric device 100, as depicted in FIG. 3. The power source may be in the form of a battery, a capacitor, a fuel cell, or alternative energy-producing or storage mechanism. Likewise, the power source may be rechargeable. Examples of alternative power sources include photocells, piezo electric generators, static generators, heat absorbers and other power generation mechanisms.

Use of the biometrically activated device of the present invention is not limited to use in credit cards. For example, a security badge could employ the present invention, allowing only the authorized user the ability to use the security badge. Likewise, drivers licenses or other identification cards using the biometrically activated device would guarantee that only the authorized user could properly operate the biometric device. For example, a drivers license could employ a biometrically activated device. The data on a drivers license, or the picture of the individual owning the drivers license, stored within the memory module could be displayed upon the proper authentication of the user of the license.

The biometrically activated device of the instant invention could additionally be utilized in cell phones. As cell phones become more advanced and more information is stored within the cell phone, it is desirable to provide a means with which to secure the data

stored therein. As cell phones and Personal Data Assistants (PDA) are integrated and combined, the need for security will become even more imperative. In order to protect such devices and restrict access to the authorized users of the device, a cell phone or PDA (or combination thereof) could be equipped with the biometrically activated device of the present invention. Thus, the cell phone or PDA could only be activated by the owner or other authorized user of the device.

Additional components connected to the biometrically activated device also expand the uses of the device. For example, instead of releasing data, such as account numbers, the memory module 120 of the device could be programmed to actuate a mechanical device, such as a door lock. The necessary control codes, or required programming in the biometrically activated device allow a user to perform mechanical functions based upon the proper authentication of the user.

It is understood that the present invention is not limited in use, but rather may be employed in any environment where it is necessary or desirable to provide an inexpensive and portable security measure which restricts use of a device to individuals having certain, programmed biometric profiles to access data or information stored within the device or initiate a process.

Embodiments of the present invention can include, but are not limited to, card-based products such as credit cards, smart cards, debit cards, ATM access cards, facilities access cards, security cards, identification cards or other card-based products requiring secure use or activation. Also included, for example, are activation mechanisms for products such as computers, microcomputers, PDA's (personal data assistants), cell phones, secure access systems, secure entry systems, software access mechanisms, PIN number replacement, firearm locks, transaction activation, or voting mechanisms. The present invention can additionally be utilized as a security feature in drivers licenses, passports, theme park passes, safebox access and the like. Further examples include the combination of the present invention with an interactive display screen or computer device to protect computers or information transmitted over the internet.

Having thus described certain preferred embodiments of the present invention, it is understood that the invention defined by the appended claims is not to be limited by particular details set forth in the above description, as many apparent variations thereof are possible without departing from the spirit or scope thereof as hereinafter claimed.

11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000
1001
1002
1003
1004
1005
1006
1007
1008
1009
1010
1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
1021
1022
1023
1024
1025
1026
1027
1028
1029
1030
1031
1032
1033
1034
1035
1036
1037
1038
1039
1040
1041
1042
1043
1044
1045
1046
1047
1048
1049
1050
1051
1052
1053
1054
1055
1056
1057
1058
1059
1060
1061
1062
1063
1064
1065
1066
1067
1068
1069
1070
1071
1072
1073
1074
1075
1076
1077
1078
1079
1080
1081
1082
1083
1084
1085
1086
1087
1088
1089
1090
1091
1092
1093
1094
1095
1096
1097
1098
1099
1100
1101
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111
1112
1113
1114
1115
1116
1117
1118
1119
1120
1121
1122
1123
1124
1125
1126
1127
1128
1129
1130
1131
1132
1133
1134
1135
1136
1137
1138
1139
1140
1141
1142
1143
1144
1145
1146
1147
1148
1149
1150
1151
1152
1153
1154
1155
1156
1157
1158
1159
1160
1161
1162
1163
1164
1165
1166
1167
1168
1169
1170
1171
1172
1173
1174
1175
1176
1177
1178
1179
1180
1181
1182
1183
1184
1185
1186
1187
1188
1189
1190
1191
1192
1193
1194
1195
1196
1197
1198
1199
1200
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
1213
1214
1215
1216
1217
1218
1219
1220
1221
1222
1223
1224
1225
1226
1227
1228
1229
1230
1231
1232
1233
1234
1235
1236
1237
1238
1239
1240
1241
1242
1243
1244
1245
1246
1247
1248
1249
1250
1251
1252
1253
1254
1255
1256
1257
1258
1259
1260
1261
1262
1263
1264
1265
1266
1267
1268
1269
1270
1271
1272
1273
1274
1275
1276
1277
1278
1279
1280
1281
1282
1283
1284
1285
1286
1287
1288
1289
1290
1291
1292
1293
1294
1295
1296
1297
1298
1299
1300
1301
1302
1303
1304
1305
1306
1307
1308
1309
1310
1311
1312
1313
1314
1315
1316
1317
1318
1319
1320
1321
1322
1323
1324
1325
1326
1327
1328
1329
1330
1331
1332
1333
1334
1335
1336
1337
1338
1339
1340
1341
1342
1343
1344
1345
1346
1347
1348
1349
1350
1351
1352
1353
1354
1355
1356
1357
1358
1359
1360
1361
1362
1363
1364
1365
1366
1367
1368
1369
1370
1371
1372
1373
1374
1375
1376
1377
1378
1379
1380
1381
1382
1383
1384
1385
1386
1387
1388
1389
1390
1391
1392
1393
1394
1395
1396
1397
1398
1399
1400
1401
1402
1403
1404
1405
1406
1407
1408
1409
1410
1411
1412
1413
1414
1415
1416
1417
1418
1419
1420
1421
1422
1423
1424
1425
1426
1427
1428
1429
1430
1431
1432
1433
1434
1435
1436
1437
1438
1439
1440
1441
1442
1443
1444
1445
1446
1447
1448
1449
1450
1451
1452
1453
1454
1455
1456
1457
1458
1459
1460
1461
1462
1463
1464
1465
1466
1467
1468
1469
1470
1471
1472
1473
1474
1475
1476
1477
1478
1479
1480
1481
1482
1483
1484
1485
1486
1487
1488
1489
1490
1491
1492
1493
1494
1495
1496
1497
1498
1499
1500
1501
1502
1503
1504
1505
1506
1507
1508
1509
1510
1511
1512
1513
1514
1515
1516
1517
1518
1519
1520
1521
1522
1523
1524
1525
1526
1527
1528
1529
1530
1531
1532
1533
1534
1535
1536
1537
1538
1539
1540
1541
1542
1543
1544
1545
1546
1547
1548
1549
1550
1551
1552
1553
1554
1555
1556
1557
1558
1559
1560
1561
1562
1563
1564
1565
1566
1567
1568
1569
1570
1571
1572
1573
1574
1575
1576
1577
1578
1579
1580
1581
1582
1583
1584
1585
1586
1587
1588
1589
1590
1591
1592
1593
1594
1595
1596
1597
1598
1599
1600
1601
1602
1603
1604
1605
1606
1607
1608
1609
1610
1611
1612
1613
1614
1615
1616
1617
1618
1619
1620
1621
1622
1623
1624
1625
1626
1627
1628
1629
1630
1631
1632
1633
1634
1635
1636
1637
1638
1639
1640
1641
1642
1643
1644
1645
1646
1647
1648
1649
1650
1651
1652
1653
1654
1655
1656
1657
1658
1659
1660
1661
1662
1663
1664
1665
1666
1667
1668
1669
1670
1671
1672
1673
1674
1675
1676
1677
1678
1679
1680
1681
1682
1683
1684
1685
1686
1687
1688
1689
1690
1691
1692
1693
1694
1695
1696
1697
1698
1699
1700
1701
1702
1703
1704
1705
1706
1707
1708
1709
1710
1711
1712
1713
1714
1715
1716
1717
1718
1719
1720
1721
1722
1723
1724
1725
1726
1727
1728
1729
1730
1731
1732
1733
1734
1735
1736
1737
1738
1739
1740
1741
1742
1743
1744
1745
1746
1747
1748
1749
1750
1751
1752
1753
1754
1755
1756
1757
1758
1759
1760
1761
1762
1763
1764
1765
1766
1767
1768
1769
1770
1771
1772
1773
1774
1775
1776
1777
1778
1779
1780
1781
1782
1783
1784
1785
1786
1787
1788
1789
1790
1791
1792
1793
1794
1795
1796
1797
1798
1799
1800
1801
1802
1803
1804
1805
1806
1807
1808
1809
1810
1811
1812
1813
1814
1815
1816
1817
1818
1819
1820
1821
1822
1823
1824
1825
1826
1827
1828
1829
1830
1831
1832
1833
1834
1835
1836
1837
1838
1839
1840
1841
1842
1843
1844
1845
1846
1847
1848
1849
1850
1851
1852
1853
1854
1855
1856
1857
1858
1859
1860
1861
1862
1863
1864
1865
1866
1867
1868
1869
1870
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884
1885
1886
1887
1888
1889
1890
1891
1892
1893
1894
1895
1896
1897
1898
1899
1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045
2046
2047
2048
2049
2050
2051
2052
2053
2054
2055
2056
2057
2058
2059
2060
2061
2062
2063
2064
2065
2066
2067
2068
2069
2070
2071
2072
2073
2074
2075
2076
2077
2078
2079
2080
2081
2082
2083
2084
2085
2086
2087
2088
2089
2090
2091
2092
2093
2094
2095
2096
2097
2098
2099
2100
2101
2102
2103
2104
2105
2106
2107
2108
2109
2110
2111
2112
2113
2114
2115
2116
2117
2118
2119
2120
2121
2122
2123
2124
2125
2126
2127
2128
2129
2130
2131
2132
2133
2134
2135
2136
2137
2138
2139
2140
2141
2142
2143
2144
2145
2146
2147
2148
2149
2150
2151
2152
2153
2154
2155
2156
2157
2158
2159
2160
2161
2162
2163
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
2178
2179
2180
2181
2182
2183
2184
2185
2186
2187
2188
2189
2190
2191
2192
2193
2194
2195
2196
2197
2198
2199
2200
2201
2202
2203
2204
2205
2206
2207
2208
2209
2210
2211
2212
2213
2214
2215
2216
2217
2218
2219
2220
2221
2222
2223
2224
2225
2226
2227
2228
2229